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GRADING HARDWOOD LOGS FOR STANDARD LUMBER

**FOREST SERVICE STANDARD
GRADES FOR HARDWOOD
FACTORY LUMBER LOGS**

**Formerly Publication No. D1737-A
Forest Products Laboratory
USDA Forest Service**

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by

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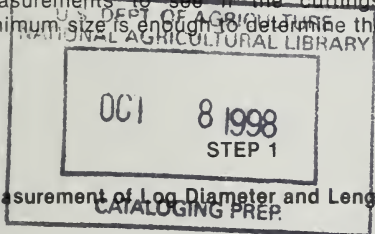
USDA Forest Service

Why Grade Logs?

A log is graded to determine its value. This value is based on the quality and volume of lumber that it will yield. When the expected lumber grade yield and its value are known, logging and milling costs can be subtracted to determine the worth of the timber. Log grades, properly applied, will give a distinct twenty percent value separation between the three grades. As a rule of thumb, grade No. 1 logs yield 60+ % 1 common and better lumber; grade No. 2 logs yield 40-60% 1 common and better grade lumber; and grade 3 logs yield 20-40% 1 common and better grade lumber.

Grading Hardwood Logs

Grading hardwood logs is *not* difficult. But it does require knowledge of defect indicators and close scrutiny to make sure no defects are overlooked. Most of the time the grade of log can be determined while it is being scaled. The grade of most logs will be fairly apparent but, even in logs where this is not the case, it is seldom necessary to lay out actual cuttings. Usually measurements to see if the cuttings conform to minimum size is enough to determine the grade.



Average diameter inside the bark on the small end of the log is used in scaling and grading. The length for figuring the necessary clear cuttings is dropped to the full foot, but cuttings are allowed to include the overlength.

STEP 2

Faces

After measuring the log, the next step is to visually square the log full length into four faces so oriented to give the largest possible number of good faces. Confine any given defect to one grading face wherever possible instead of permitting it to extend over two faces unnecessarily. The grade of the log will be established by the poorest face of the best three faces. In other words, disregard the poorest face on the log, and grade the poorest of the remaining three faces. This is the grade of the log.

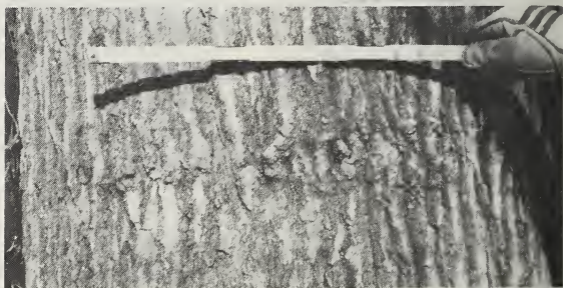
STEP 3

Clear Cuttings

The grade of a face is established on the basis of clear cutting requirements. Clear cuttings are portions of the length of the face that lie between defects or between the ends of the logs and defects, and extend the full width of the face.

A surface abnormality, if determined to extend into the log for a depth more than 15% of the diameter at the point of occurrence, is a log grade defect. Otherwise, it should be disregarded.

Defects



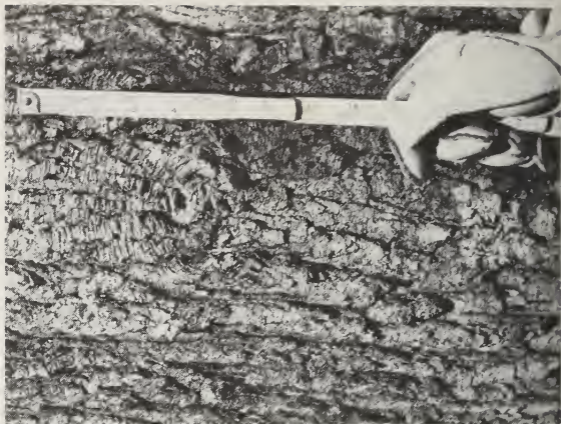
Slight bark distortion, consisting of a simple horizontal break across the normal bark pattern — *not* a defect.



Medium bark distortion consisting of breaks across and along the normal bark pattern — a defect in *all* diameter logs.



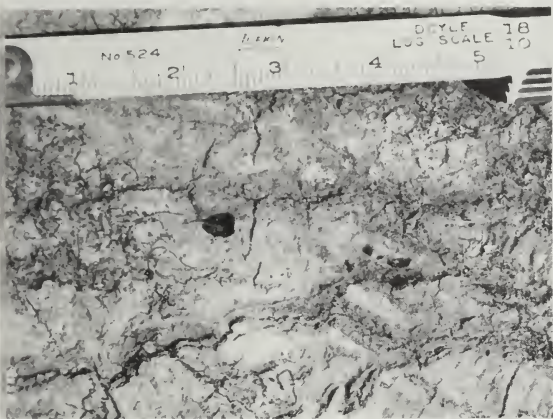
Small bark distortion, consisting of a break in the normal bark pattern but not clearly an overgrown knot — not a defect in 15-inch and larger logs.



Bark distortion that clearly is an overgrown knot — a defect in *all* diameter logs.



Adventitious twig growth $\frac{3}{8}$ " or less in diameter is a defect in logs under 14" d.i.b. On logs 14" and larger, only every other one is considered a defect. In the soft hardwoods it is not considered a defect in grade 3 logs.



Grub holes or other insect holes open or overgrown are defects on all logs under 16" d.i.b.

On logs 16" - 19" d.i.b. — disregard every 6th one.

On logs 20" - 23" d.i.b. — disregard every 5th one.

On logs 24" - 27" d.i.b. — disregard every 4th one.

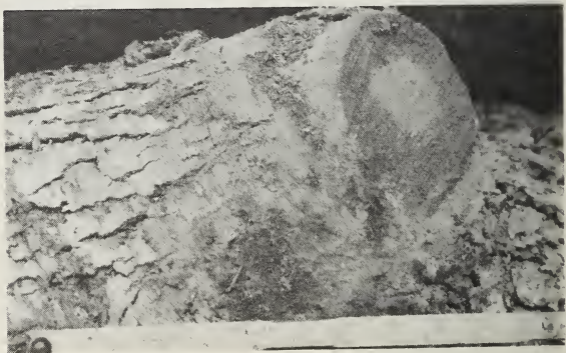
On logs 28" + d.i.b. — disregard every 3rd one.



A bump is defined as any bark covered protuberance with gradual to abrupt sloping sides, the cause of which is not clearly evident.

Bumps are not considered defects in logs under 14" d.i.b. when the length of the bump is 16 or more times its height. In logs 14" d.i.b. and over, bumps are not considered defects when the length of the bump is 12 or more times its height.

A clear cutting may extend into both ends of bumps by $\frac{1}{4}$ when length is 6 or more times the height by $\frac{1}{8}$ when length is 3 to 5 times the height.



For measurement of clear cuttings adjacent to large coarse, elevated defects, the size of which is taken flush with the bark surface:

2" - 4" defects: cuttings may extend $\frac{1}{2}$ " above flush bark surfaces.

5" - 7" defects: cuttings may extend 1" above flush bark surfaces.

8" + defects: cuttings may extend $1\frac{1}{2}$ " above flush bark surfaces.

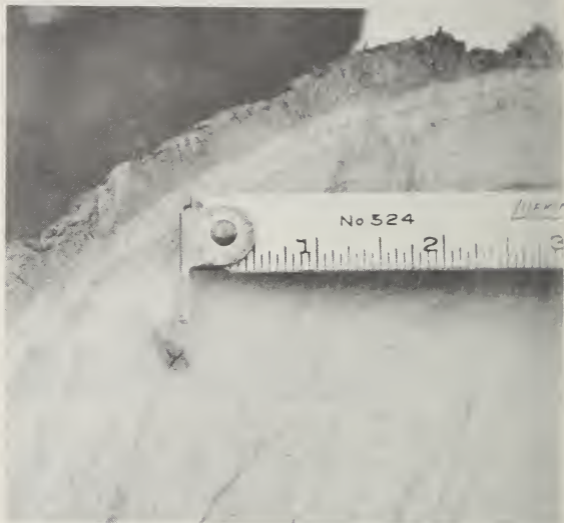
End Defects

All abnormalities, regardless of type, can be disregarded in grading when they are confined to the heart center. (see Figures 1 and 2)

Sound end defects, such as medium to heavy mineral stain and slight dote on the small end of the log, shall not exceed $\frac{1}{2}$ the log d.i.b. for grade 1 and grade 2 logs under 16" d.i.b. and not exceed $\frac{3}{5}$ the log diameter on grade 2 logs 16" and larger. Over this amount, lower the log one grade. When the defect is not concentrated in one spot, its extent is taken as the sum of the individual occurrences. Slight stain is not a defect.

If *unsound end defects* such as decay and heavy shake extend more than $\frac{1}{2}$ the distance between the heart zone and the bark, clear cuttings cannot be taken on the face overlying it. If the defect extends less than full length of the log, however, cuttings can be taken over $\frac{1}{3}$ of its estimated length from the end tapering out.

Specific end defects such as bird peck, wormholes, spot wormhole stain, mineral spots or streaks, and such unsound defects as grub holes and bark pockets must be considered when outside the heart zone. When these defects affect more than $\frac{1}{2}$ the radial distance between the heart zone and the bark under three faces of the log at one end or two faces at both ends, a log grade 1 or 2 shall be reduced one grade. When there is less than 3 inches between the heart zone and the defect, or between defects, the portion will be included with the defect.



Bird Peck Defect

Disregard all pecked areas in grade 3 logs. Fresh or light birdpeck may be disregarded in grades 1 and 2 logs. The test for freshness is the lack of associated similar holes that are occluded. Measure of lightness is four pecks per square foot.

Seams

A seam, frost crack, split, etc. is not a defect unless it goes deeper than 15% of the log diameter. No clear cuttings can be taken on a log face that includes a full length straight seam or a spiral seam. However, one straight seam can be placed on the edge of one face and disregarded. A deep seam not running the full length of the log may be overlaid with a clear cutting for 1/3 of its length, starting at the inner end.

Sweep, Crook, and Cull Deductions

The National Forest Log Scaling Handbook (FSH 2443.71) can be used for making scale deductions as can Grosenbaugh's rules. (See Figure 3).

Table 2 gives sweep deductions based on Grosenbaugh's Rule 3.

Tables 3 and 4 used together give interior scale deductions based on Rule 5.

- 1) In table 3, find factor for log scaling diameter (inches) and length of scaling defect section (percent of log length).
- 2) In table 4, find factor for short and long dimension of defect cross section.
- 3) Multiply the two factors to get scale deduction in percent of log scale.

Yield of Clear Cuttings

Required yields are given in fractions for simplicity of application. For a $5/6$ yield, use 10 times the nominal length of log in feet as equal to the required total clear length in inches. For example: for a 12 foot log, $10 \times 12 = 120$ inches or 10 feet required for a grade 1 face.

For a $4/6$ yield, use $8 \times$ length; for $3/6$, use $6 \times$ length.

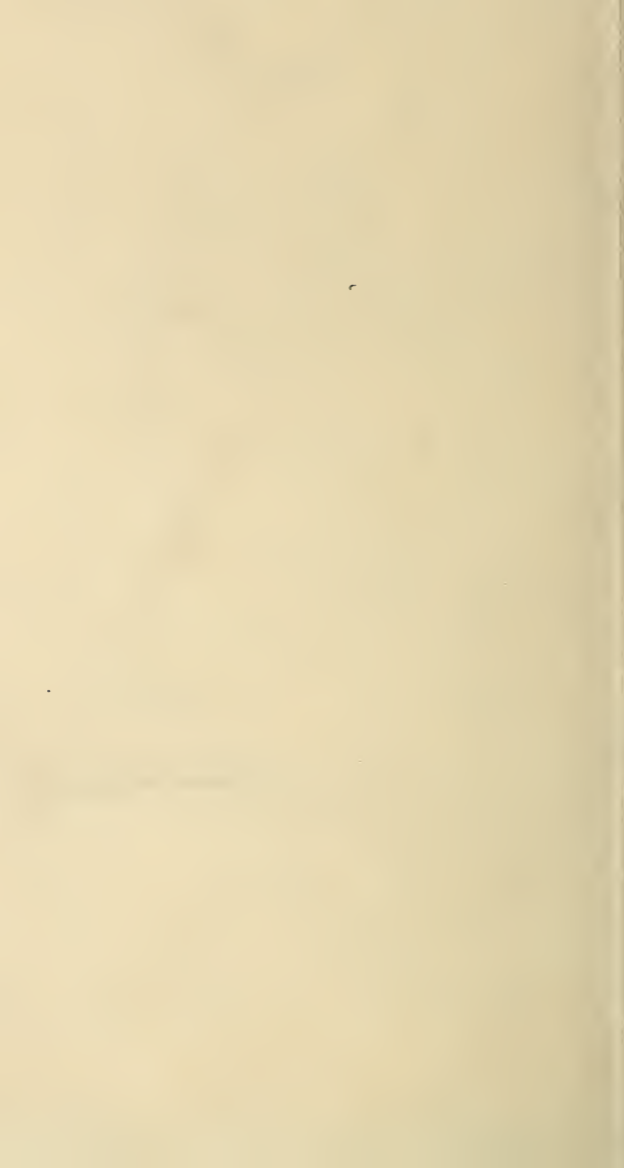
The amount permissible to lose can also be used, as Table 1 illustrates.

Table 1. TOTAL CUTTING LENGTHS FOR HARDWOOD LOG GRADES

Log Length (feet)	Log Grade					
	1 ($5/6$ yield)		2 ($4/6$ yield)		3 ($1/2$ yield)	
	Clear	Lose	Clear	Lose	Clear	Lose
10	8'4"	1'8"	6'8"	3'4"	5'	5'
12	10'	2'	8'	4'	6'	6'
14	11'8"	2'4"	9'4"	4'8"	7'	7'
16	13'4"	2'8"	10'8"	5'4"	8'	8'

For No. 1 — Length times 2 gives inches can lose.

For No. 2 — Length times 4 gives inches can lose.



Forest Service standard specifications for hardwood factory lumber logs. (from FPL 63)

Grading Factors		Log Grades							
		F1			F2				F3
Position in tree		Butts only	Butts & uppers		Butts & uppers				Butts & uppers
Diameter, scaling		<u>1</u> 13"-15"	16"-19"	20" +	<u>2</u> 11"	12" +			8" +
Length without trim		10' +			10'+	8-9'	10-11'	12' +	8' +
Clear cuttings <u>3</u> on each 3 best faces	Length, min.,	7'	5'	3'	3'	3'	3'	3'	2'
	Number, maximum	2	2	2	2	2	2	3	No limit
	Fraction of log length required in clear cutting <u>4</u>	5/6	5/6	5/6	2/3	3/4	2/3	2/3	1/2
Sweep and crook allowance (maximum) in percent gross volume	For logs with less than 1/4 of end in sound defects	15%			30%				50%
	For logs with more than 1/4 of end in sound defects	10%			20%				35%
Total scaling deduction including sweep and crook		<u>5</u> 40%			<u>6</u> 50%				50%
End defects:					See instructions Page 7				

1 Ash and basswood butts can be 12 inches if they meet all other No. 1 requirements. 2 Ten-inch logs of all species can be No. 2 if they meet all other No. 1 requirements. 3 A clear cutting is a portion of a face free of defects, extending the width of the face. 4 See Table No. 1. 5 Otherwise No. 1 logs with 41-60% deductions can be No. 2. 6 Otherwise No. 2 logs with 51-60% deductions can be No. 3.

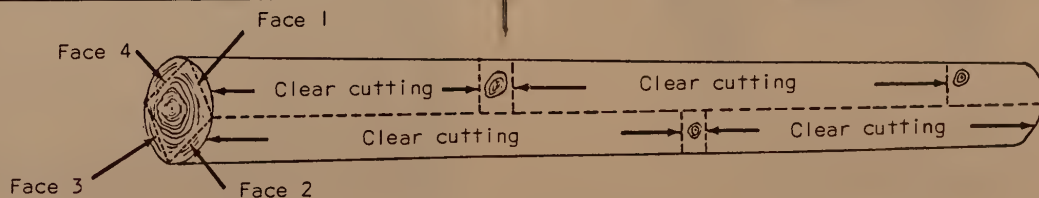


Figure 1.—Location of end features in hardwood factory lumber logs.

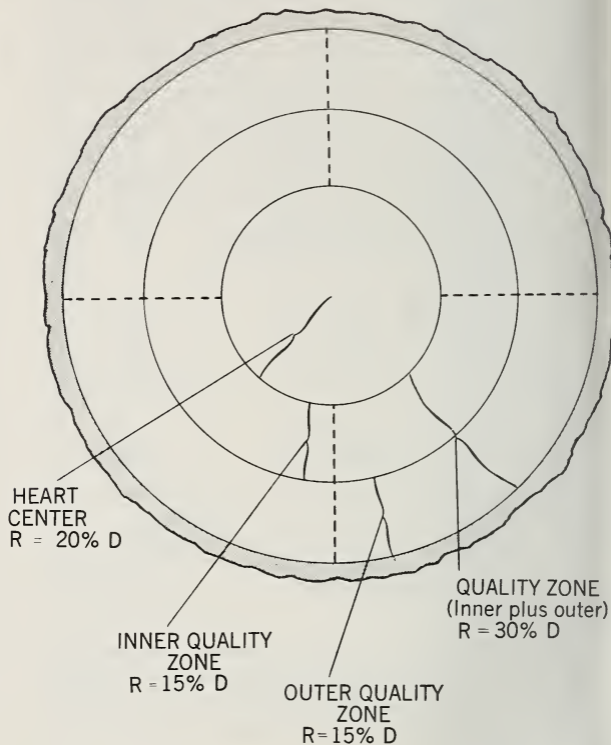
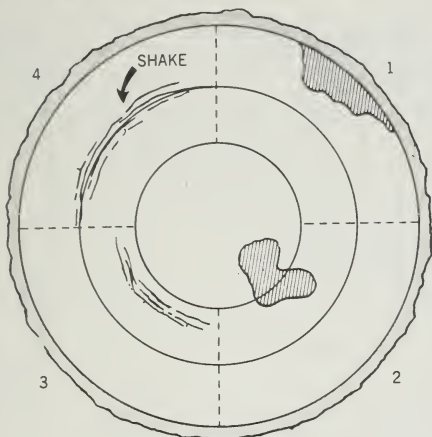
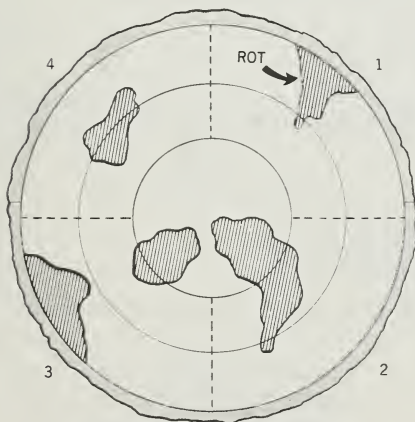


Figure 2.— Evaluation of rot and shake in hardwood factory lumber logs.

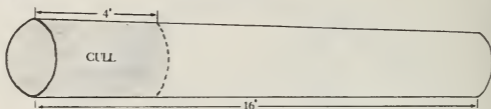


Rot no defect in quadrant 1 or 2
Shake no defect in quadrant 3
Shake is a defect in quadrant 4



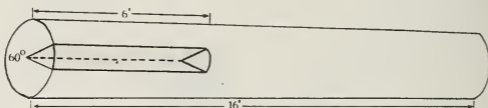
Rot is defect in all 4 quadrants

Figure 3. Methods of determining scaling deduction
(Examples based on a 16-foot log with 20-inch scaling diameter)



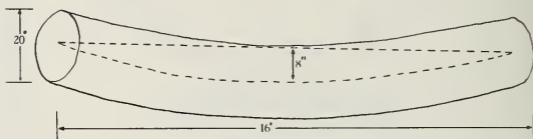
Defect section (rule 1):

$$\text{Percent deduction} = \frac{4}{16} = 25\%$$



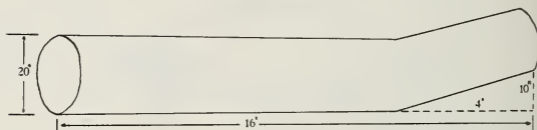
Defect section (rule 2):

$$\text{Percent deduction} = \left(\frac{6}{16} \right) \left(\frac{60}{360} \right) = 6.1/4\%$$



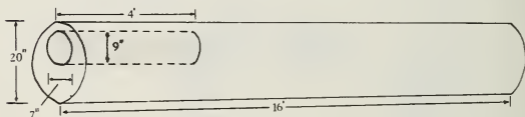
Sweep (rule 3):

$$\text{Percent deduction} = \frac{8 - 2}{20} = 30\%$$



Crook (rule 4):

$$\text{Percent deduction} = \left(\frac{10}{20} \right) \left(\frac{4}{16} \right) = 12.1/2\%$$



Interior defect (rule 5):

$$\text{Percent deduction} = \frac{(8)(10)}{(20 - 1)^2} \times \frac{4}{16} = 5.5/9\%$$

In practice each ellipse axis can be divided by $(20 - 1)$ and rounded to nearest tenth if desired.

$$\text{Thus } \frac{8}{19} = .4, \frac{10}{19} = .5, \text{ and } (.4)(.5) \left(\frac{4}{16} \right) = 5\%$$

TABLE 2. Sweep Deduction from gross scale by length and diameter (in percent; based on rule 3)

Absolute sweep in inches		Scaling diameter, average small end inside bark, in inches											
8-9-10 foot logs	14-15-16 foot logs	8	10	12	14	16	18	20	22	24	26	28	30
—	3	12	10	8	7	6	6	5	5	4	4	4	3
3	4	25	20	17	14	12	11	10	9	8	8	7	7
4	5	38	30	25	21	19	17	15	14	12	12	11	10
5	6	50	40	33	29	25	22	20	18	17	15	14	13
6	7	62	50	42	36	31	28	25	23	21	19	18	17
7	8	—	60	50	43	38	33	30	27	25	23	21	20
8	9	—	—	58	50	44	39	35	32	29	27	25	23
9	10	—	—	67	57	50	44	40	36	33	31	29	27
10	11	—	—	—	64	56	50	45	41	38	35	32	30
11	12	—	—	—	—	62	56	50	45	42	38	36	33
12	13	—	—	—	—	—	61	55	50	46	42	39	37
13	14	—	—	—	—	—	—	60	54	50	46	43	40
14	15	—	—	—	—	—	—	65	59	54	50	46	43
15	16	—	—	—	—	—	—	—	64	58	54	50	47
16	17	—	—	—	—	—	—	—	—	62	58	54	50
17	18	—	—	—	—	—	—	—	—	—	62	57	53
18	19	—	—	—	—	—	—	—	—	—	65	61	57
19	20	—	—	—	—	—	—	—	—	—	—	64	60
20	21	—	—	—	—	—	—	—	—	—	—	—	63
21	22	—	—	—	—	—	—	—	—	—	—	—	67
11-12-13 foot logs													
3		19	15	12	11	9	8	8	7	6	6	5	5
4		31	25	21	18	16	14	12	11	10	10	9	8
5		44	35	29	25	22	19	18	16	15	13	12	12
6		56	45	38	32	28	25	22	20	19	17	16	15
7		—	55	46	39	34	31	28	25	23	21	20	18
8		—	65	54	46	41	36	32	30	27	25	23	22
9		—	—	62	54	47	42	38	34	31	29	27	25
10		—	—	—	61	53	47	42	39	35	33	30	28
11		—	—	—	—	59	53	48	43	40	37	34	32
12		—	—	—	—	66	58	52	48	44	40	38	35
13		—	—	—	—	—	64	58	52	48	44	41	38
14		—	—	—	—	—	—	62	57	52	48	45	42
15		—	—	—	—	—	—	—	61	56	52	48	45
16		—	—	—	—	—	—	—	66	60	56	52	48
17		—	—	—	—	—	—	—	—	65	60	55	52
18		—	—	—	—	—	—	—	—	—	63	59	55
19		—	—	—	—	—	—	—	—	—	67	62	58
20		—	—	—	—	—	—	—	—	—	—	66	62
21		—	—	—	—	—	—	—	—	—	—	—	65

Note: For odd lengths and half inches of sweep, deductions can be interpolated from the figures given

TABLE 3. Scaling diameter: defect length factors

Scaling diameter inches	Percent of log length in cull section									
	10	20	30	40	50	60	70	80	90	100
8	1.2	2.4	3.5	4.7	5.9	7.1	8.2	9.4	10.6	11.8
9	.9	1.8	2.7	3.6	4.5	5.4	6.3	7.2	8.1	9.0
10	.7	1.4	2.1	2.8	3.6	4.3	5.0	5.7	6.4	7.1
11	.6	1.1	1.7	2.3	2.9	3.4	4.0	4.6	5.2	5.8
12	.5	1.0	1.4	1.9	2.4	2.9	3.3	3.8	4.3	4.8
13	.4	.8	1.2	1.6	2.0	2.4	2.8	3.2	3.6	4.0
14	.3	.7	1.0	1.4	1.7	2.0	2.4	2.7	3.1	3.4
15	.3	.6	.9	1.2	1.5	1.8	2.1	2.4	2.6	2.9
16	.3	.5	.8	1.0	1.3	1.5	1.8	2.0	2.3	2.6
17	.3	.4	.7	.9	1.1	1.4	1.6	1.8	2.0	2.3
18	.2	.4	.6	.8	1.0	1.2	1.4	1.5	1.8	2.0
19	.2	.4	.5	.7	.9	1.1	1.2	1.4	1.6	1.8
20	.2	.3	.5	.6	.8	1.0	1.1	1.3	1.4	1.6
21	.2	.3	.4	.6	.7	.9	1.0	1.2	1.3	1.4
22	.1	.3	.4	.5	.7	.8	.9	1.0	1.2	1.3
23	.1	.2	.4	.5	.6	.7	.8	1.0	1.1	1.2
24	.1	.2	.3	.4	.5	.6	.8	.9	1.0	1.1
25	.1	.2	.3	.4	.5	.6	.7	.8	.9	1.0

Note: Do not take off an inch in measuring diameter.

TABLE 4. Interior defect cross-section factors

Short axis, inches	Long axis, inches													
	2	3	4	5	6	7	8	9	10	11	12	13	14	15
2	2	2	3	3	4	4	5	5	6	6	7	7	8	8
3	—	3	3	4	5	5	6	7	8	8	9	10	10	11
4	—	—	4	5	6	7	8	9	10	10	11	12	13	14
5	—	—	—	6	7	8	9	10	11	12	14	15	16	17
6	—	—	—	—	8	10	11	12	13	15	16	17	18	19
7	—	—	—	—	—	11	12	14	15	17	18	19	21	22
8	—	—	—	—	—	—	14	16	17	19	20	22	23	25
9	—	—	—	—	—	—	—	17	19	21	23	24	26	28
10	—	—	—	—	—	—	—	—	21	23	25	27	29	31
11	—	—	—	—	—	—	—	—	—	25	27	29	31	33
12	—	—	—	—	—	—	—	—	—	—	29	32	34	36
13	—	—	—	—	—	—	—	—	—	—	—	34	36	39
14	—	—	—	—	—	—	—	—	—	—	—	—	39	42
15	—	—	—	—	—	—	—	—	—	—	—	—	—	44
16	—	—	—	—	—	—	—	—	—	—	—	—	—	—
17	—	—	—	—	—	—	—	—	—	—	—	—	—	—
18	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Note: Do not add a collar allowance in measuring axes.

Table 5. — International decimal ¼-inch log rule

D.i.b. (inches)	Length in feet				
	8	10	12	14	16
6	10	10	10	20	20
7	10	20	20	20	30
8	20	20	30	30	40
9	20	30	40	40	50
10	30	40	50	60	60
11	40	50	60	70	80
12	40	60	70	80	100
13	50	70	80	100	120
14	60	80	100	120	140
15	70	90	110	140	160
16	80	110	130	160	180
17	100	120	150	180	210
18	110	140	170	200	230
19	120	160	190	220	260
20	140	170	210	250	290
21	150	190	230	280	320
22	170	210	260	310	350
23	190	240	280	340	390
24	200	260	310	370	420
25	220	280	340	400	460
26	240	300	370	430	500
27	260	330	400	470	540
28	280	360	430	510	580
29	300	380	460	550	630
30	330	410	500	590	670

Computed from volume of 4-foot section for 1/8" sawkerf = $0.22D^2 - 0.71D$ and on assumed taper of 1/2 inch in 4 feet. Result multiplied by 0.905 to convert to 1/4" sawkerf. Computed by Northeastern Forest Experiment Station, 1951.

Table 6. Doyle log rule, contents of logs in board feet

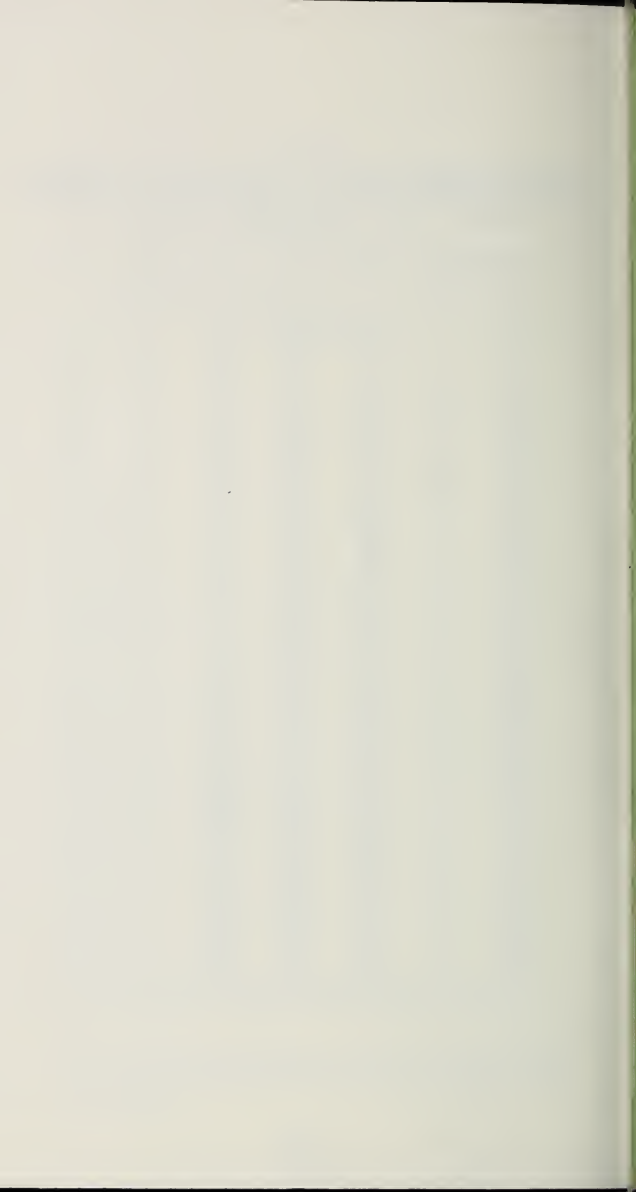
Scaling diameter	Log length in feet				
	8	10	12	14	16
In. Board feet				
6*	2	3	3	4	4
7*	5	6	7	8	9
8	8	10	12	14	16
9	13	16	19	22	25
10	18	23	27	32	36
11	25	31	37	43	49
12	32	40	48	56	64
13	41	51	61	71	81
14	50	63	75	88	100
15	61	76	91	106	121
16	72	90	108	126	144
17	85	106	127	148	169
18	98	123	147	172	196
19	113	141	169	197	225
20	128	160	192	224	256
21	145	181	217	253	289
22	162	203	243	284	324
23	181	226	271	316	361
24	200	250	300	350	400
25	221	276	331	386	441
26	242	303	363	424	484
27	265	331	397	463	529
28	288	360	432	504	576
29	313	391	469	547	625
30	338	423	507	592	676

*It is common practice in the South to assign logs 8" d.i.b. and under their length as the Doyle Scale of the log.

Table 7.

Scribner Decimal C log rule, contents of logs in board feet

Scaling	Log length in feet				
Diameter	8	10	12	14	16
In. Board feet				
6	5	10	10	10	20
7	10	10	20	20	30
8	10	20	20	20	30
9	20	30	30	30	40
10	30	30	30	40	60
11	30	40	40	50	70
12	40	50	60	70	80
13	50	60	70	80	100
14	60	70	90	100	110
15	70	90	110	120	140
16	80	100	120	140	160
17	90	120	140	160	180
18	110	130	160	190	210
19	120	150	180	210	240
20	140	170	210	240	280
21	150	190	230	270	300
22	170	210	250	290	330
23	190	230	280	330	380
24	210	250	300	350	400
25	230	290	340	400	460
26	250	310	370	440	500
27	270	340	410	480	550
28	290	360	440	510	580
29	310	380	460	530	610
30	330	410	490	570	660



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